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RECORD OF REVISIONS

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RESPONSIBLE ESM POC AND COMMITTEE

for upkeep, interpretation, and variance issues

Section F1030.2	Radiation Protection POC/Committee

F1030.2 RADIATION PROTECTION DESIGN (PROGRAMMATIC & FAC)

1.0 APPLICATION OF CHAPTER

A. This chapter helps ensure that nuclear and radiological facilities are designed and constructed to prevent accidents and mitigate consequences; yet are efficient, convenient, and adequate for good service; minimize the generation of hazardous, radioactive, and mixed waste; and are maintainable, standardized, and adequate for future expansion.

B. This chapter contains requirements and guidance that applies to design and construction, both new construction and modification of existing installations for new efforts as described by LIR 220-03-01, Engineering Standards.[1]

C. This chapter shall be used in conjunction with LANL Implementation Requirement document LIR402-700-01, Occupational Radiation Protection Requirements, which outlines the requirements from the federal requirements of Title 10 CFR Part 835, Occupational Radiation Protection. Other drivers are DOE Order 420.1A and DOE Order 6430.1A, Section 13 (all in LANL Work Smart Standards).

D. Note: DOE Order 420.1A is a document that incorporates the federal requirements of Title 10 Part 835 Occupational Radiation Protection Requirements. References to 10CFR835 herein cover the requirements of DOE Order 420.1 and Guidance. Therefore, this chapter, along with other chapters of the Engineering Standards Manual, comprehensively implements requirements and guidance in DOE O 420.1A, Facility Safety, and its two guides, (1) DOE G 420.1-1, Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for use with DOE O 420.1 Facility Safety and (2) DOE G 420.1-2, Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and NonNuclear Facilities, along with providing additional requirements.

E. Use this chapter along with Chapter 1-General, Chapter 10-Hazardous Process, Chapter 12-Nuclear, and other ESM chapters as applicable.

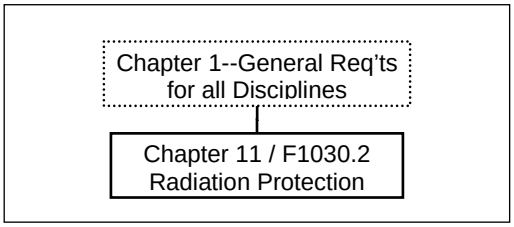
F. In addition to the variance requirements in ESM Chapter 1 Section Z10, approval of the HSR Division Leader is also required on the LIR301-00-02 form (*1661a*).

G. WARNING: Failure of nuclear facilities/activities to comply with the 10 CFR 835 requirements that are further promulgated by DOE O 420.1A could result in civil enforcement under PAAA against the UC/LANL. LANL cannot waive these requirements without going through a formal exemption process with NNSA/DOE approval in accordance with 10CFR820.

Note: Guidance statements are in *ITALICS* and generally follow the paragraph they support.

H. All new facility-related design, material, equipment, and installations shall comply with the requirements in this chapter and Chapter 1 of the ESM.[2] This entire chapter is also applicable to programmatic structures, systems, and components (SSC) unless specifically noted otherwise.

I. The hierarchy and the organization of the ESM for this chapter is depicted below:



2.0 ACRONYMS AND DEFINITIONS

ALARA	As low as reasonably achievable.
CAM	continuous air monitor.
co-mingling	The ability of an individual in or from a radiologically controlled area and an individual in a uncontrolled area to come in contact with each other.
design agency	The organization performing the detailed design and analysis of a project or modification.
ESH Coordinator	Project lead to ensure environmental, safety and health features are incorporated into the design by coordinating with ES&H SMEs for design features and design reviews.
ESM	Engineering Standards Manual.
facility	Normally at LANL, facility is a synonym for Real Property and Installed Equipment. RP&IE is the land, improvements on the land such as buildings, roads, fences, bridges, and utility systems and the equipment installed as part of the basic building construction that is essential to normal functioning of a building space, such as plumbing, electrical and mechanical systems. This property/equipment is also referred to as institutional or plant and was formerly known as Class A. [from DOE Order 4330.4B] **In the context of this chapter's nuclear-applicable sections, facility refers to the definition of nuclear facility in 10 CFR 830 and includes process (programmatic) systems and activities.**
F&OR	Functional and Operational Requirements (F&OR) document establishes the tasks, activities, operations, support facility or system process requirements, and specific operations and facility characterization data in sufficient detail to permit the project to quantify and qualify project design requirements.
LIR	Laboratory implementation requirements.
mixed waste	MW contains both hazardous waste (as defined by RCRA and its amendments) and radioactive waste (as defined by Atomic Energy Act and its amendments). It is jointly regulated by NRC or NRC Agreement States and EPA or EPA's RCRA Authorized States. The fundamental and most comprehensive statutory definition is found in the Federal Facilities Compliance Act (FFCA) where Section 1004(41) was added to RCRA: "The term 'mixed waste' means waste that contains both hazardous waste and source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954."

ML	Management level, defined in LIR 230-01-02, Graded Approach for Facility Work (or Programmatic equivalent). http://labreq.lanl.gov/pdfs/ops/01_operations/lir2300102.pdf. *Guidance: Related LIG: http://labreq.lanl.gov/pdfs/ops/01_operations/lig2300102.pdf*
Nonreactor nuclear facility	means those facilities, activities or operations that involve, or will involve, radioactive and/or fissionable materials in such form and quantity that a nuclear or a nuclear explosive hazard potentially exists to workers, public, or the environment, but does not include accelerators and their operations and does not include activities involving only incidental use and generation of radioactive materials or radiation such as check and calibration sources in research and experimental and analytical laboratory activities, electron microscopes, and X-ray machines.[10CFR830]
nuclear facility	means a reactor or a nonreactor nuclear facility where an activity is conducted for or on behalf of DOE and includes any related area, structure, facility, or activity to the extent necessary to ensure proper implementation of established requirements.[10CFR830]
Optimization	To demonstrate the expense (i.e., money, person-rem, dose to install and maintain, etc.) of a project or feature of a project is justified in terms of the benefit received. This is in accordance with the idea of balancing ALARA considerations against technological, social, operational, and economic considerations.
POC	Point of contact. For the ESM discipline POCs see http://www.lanl.gov/f6stds/pubf6stds/engrman/HTML/poc_techcom1.htm
Project Lead	Project manager (assigned by organization), project leader (assigned by PM Division) or other designated individual responsible for the management and overall design effort of the project.
Project Manager	Individual assigned by the User/Program Office and is responsible for the project.
programmatic	A synonym for Personal Property and Programmatic Equipment. PP&PE is equipment used purely for programmatic purposes, such as reactors, accelerator machinery, chemical processing lines, lasers, computers, machine tools, etc., and the support equipment dedicated to the programmatic purpose. This property/equipment is also referred to as organizational, research, production, operating or process and was formerly known as Class B. [DOE Order 4330.4B]
SSC	Structures, systems, and components.

3.0 DESIGN CRITERIA [3]

3.1 General

A. Responsibilities: The Project Lead shall ensure that projects or facilities under their control receive radiological engineering design input at the earliest possible time in the design process. The Project Lead is responsible for radiological protection design and implementing design input with the assistance of the Project Radiological Engineer Coordinator. A qualified HSR-12 Radiological Engineering Team member or approved Radiological Engineer by HSR-12 Group Leader will perform a formal radiological design review at appropriate design phases. The formal radiological engineering and operational review of the design shall be performed before actual construction or modification begins.[4]

1. Project Lead is responsible for the design of LANL structures, systems, and components, and are responsible for ensuring that their Design Agent implements the stated requirements.

B. LANL Radiological Subject Matter Experts: LANL has several institutional and national Radiological Subject Matter Experts for design input or oversight. The SMEs will help ensure appropriate design features and considerations are incorporated in the design through the design and design review process. They are:

1. Radiological Operations to include external radiation and airborne radioactivity detection: HSR-1 Health Physics Operations
2. Radiation Instrumentation SME: HSR-4 Health Physics Measurements
3. Airborne Radioactivity Detection SME: HSR-1 Health Physics Operations & HSR-4 Health Physics Measurements
4. Radiological Ventilation SME: HSR-5 Industrial Hygiene and Safety
5. Criticality Design and Safety SME: HSR-6 Nuclear Criticality Safety
6. ALARA Plans and Design Review: HSR-12 Radiological Engineering Team
7. Radiological Engineering Design SME: HSR-12 Radiological Engineering Team
8. Radiological Engineering Project Coordinator: HSR-12 Radiological Engineering Team
9. Waste minimization assistance should include LANL RRES-Pollution Prevention program support.

C. Qualified Radiological Engineer: The HSR Division Director or HSR-12 Radiation Protection Services Group Leader -- with recommendation from the HSR-12 Radiological Engineering Team Leader – shall determine if a LANL individual is a qualified for the type of radiological project design and analysis.

1. The minimum requirements for a qualified project radiological engineer are:

- Baccalaureate or higher in science, health physics or engineering to include formal training in radiation protection.
- At least three years of DOE radiological activity experience with a minimum of 1 year of operational radiation protection at a DOE facility or elsewhere.
- Certification by the American Board of Health Physics or equivalent.

- On-site a minimum of six months
- At least three months mentoring by HSR-12 Radiological Engineering Team.

2. The approval is based on the type of project and the radiological engineer's experience to provide the project a qualified radiological engineer.

D. Design ALARA Review: A formal ALARA design review of the operations and design shall be performed if:

1. The operational work involves dispersible radioactive material or contaminated systems, or
2. Organization doses are likely to exceed the following annual Total Effective Dose Equivalent:

- 2-person-rem collective dose;
- 0.5-rem individual dose; or
- 0.1-rem average individual dose.[5]

3.2 Radiological Design Regulatory Requirements

A. Measures shall be taken to maintain radiation exposure in controlled areas ALARA through physical features and administrative control.[6]

1. The primary methods used shall be physical features (e.g., confinement, ventilation, remote handling, and shielding).[7]
2. Administrative controls shall only be employed as supplemental methods to control radiation exposure.[8]
3. For specific radiological activities, in which, design features that have been demonstrated to be impractical, administrative controls shall be used to maintain radiation exposure ALARA. The use of administrative controls instead of physical controls shall be documented and approved by the Project Lead and the Project Radiological Engineering Coordinator. [9]

B. Optimization methods shall be used to assure that occupational exposure is maintained ALARA in developing and justifying facility design and physical controls.[10]

C. Continuously Occupied Areas for Radiological Workers (*rare if ever*) – The design objective shall be to maintain exposure levels ALARA and below an average of 0.5 millirem per hour.[11]

D. Non-Continuously Occupied Areas for Radiological Workers (*usually the case*) – The design objective shall be to maintain exposure levels ALARA and below 20% of the applicable standard in 10CFR835.202 in areas not continuously occupied (less than 2000 hours/year) as outlined in Table 3.2.1.[12]

Table 1. Occupational and Design Dose Limits			
Type of Dose Limit	**Annual Dose Limit** LIR402-700-01.422/ 10CFR835.202 **(rems)**	**Design Dose Limit** 20% of Annual Dose Limit **(rem)**	**(mrem)**
Total Effective Dose Equivalent	5	1	1,000
Deep Dose Equivalent	50	10	10,000
Lens of eye Dose Equivalent	15	3	3,000
Shallow Dose Equivalent (skin and any extremity)	50	10	10,000

E. Airborne Radioactive Material - Design shall ensure that, under normal conditions, the design avoids the release of airborne radioactive material to the workplace. Confinement and ventilation shall normally be used.[13]

F. Inhalation of Radioactive Material - Design shall ensure that, under any condition, the design controls the inhalation of radioactive materials by workers to a level that are ALARA. Confinement and ventilation shall normally be used.[14]

G. Selected Material for Radiological Area – Design objective shall be to select appropriate materials in facility construction or modification to facilitate operations, maintenance, decontamination, and decommissioning.[15]

H. Workplace Monitoring – The design shall incorporate appropriate radiation monitoring devices to demonstrate the radiation exposure levels are ALARA.[16]

I. Radioactive liquid waste shall meet the waste acceptance criteria of the receiving facility as specified in the latest version of the LANL Waste Acceptance Criteria (PLAN-WASTEMGMT-002 or most recent version)[17]

J. Nuclear criticality safety shall be evaluated by LANL's HSR-6 Nuclear Critical Safety Group to ensure the design of the liquid radioactive waste system is appropriate and does not create an accidental criticality issue. [18]

K. Dose rates shall be determined 1 foot from a wall surface and 2 feet from a floor or roof, unless evaluating hand or upper extremity doses.[19]

L. Fluence-to-dose conversion factors used in analysis shall relate to the conversion factors used to calibrate radiation instrumentation and dosimeters at Los Alamos National Laboratory (ANSI 1977 – ANSI/ANS-6.1.1-1977 Neutron and Gamma Flux-to-dose-rate factors), unless otherwise approved by the project.[20]

M. Radioactive liquid waste from controlled areas shall be collected and transferred to the industrial (radioactive) liquid waste treatment line, appropriate holding tanks or retention systems.[21]

N. Every sink, water fountain, shower and other liquid devices, except toilets and urinals, located in a radiologically controlled area shall be connected to the radioactive waste liquid system.[22]

O. Breathing air must meet grade D requirements delineated in Compressed Gas Association (CGA) Specification G-7.1. Compressors, air lines, fittings, cylinders, and related equipment shall comply with 29CFR1910.134(d), and ANSI Z88.2(10). Monitoring of breathing air quality is required under ANSI Z88.2(10.5.4.3). Contact HSR-5 for details related to breathing air and to ensure requirements have not changed.

P. When a new or modification to an existing facility are planned, the design project management team shall notify and coordinate with HSR-12 radiological Engineering Team for radiological engineering design support and/or review of the project design.[23]

Q. A formal radiological engineering analysis and design review is required if any of the following conditions or facility types are expected to prevail, of if one of the conditions is expected to be present later in the life of the facility.[24]

1. Dose rate exceeds 0.5 mrem/hour at 30 cm from any surface in the facility or areas occupied by radiological workers during routine operations.
2. A reasonable potential for inhaling airborne radioactive material in the facility during routine operation is present.
3. A reasonable potential for contamination exceeding Table 14-1, Chapter 14, LIR402-700-01, contamination values in the facility during normal operations is present.
4. A reasonable potential for public or non-radiological worker exposure worker exposure during routine operation is present.
5. The facility is defined as any of the following:
    a. plutonium processing and handling facilities
    b. plutonium storage facilities
    c. un-irradiated enriched uranium storage facilities
    d. explosives facilities (using radioactive materials)
    e. uranium processing and handling facilities
    f. irradiated fissile material storage facilities
    g. reprocessing facilities
    h. uranium conversion and recovery facilities
    i. radioactive liquid waste facilities
    j. radioactive solid waste facilities
    k. laboratory facilities (using radioactive materials in hot cells, glove boxes, hoods, or similar enclosures)
    l. accelerators
    m. x-ray devices capable of generating a dose rate ≥ 100 mrem in an hour at 1 foot
    n. tritium facilities
    o. fusion test facilities

3.3 Design Considerations and Features (Guidance)

A. Appendix A has a list of radiological functional and design considerations and features to ensure the above mentioned design objectives and requirements are met. The radiological design considerations and features provided in Appendix A are not inclusive and not every item is required for every radiological design due to the type of operation or facility. The project shall have a qualified radiological engineer to assist in the design process and determine the design features needed to be considered by the project and which items do not. Additional design items might need to be considered based on the design of a new or modified operation or facility. The functional and design criteria areas in Appendix A are:

1. Function and Operational Requirement (F&OR) Document & Radiological Design Criteria
2. Safety Analysis
3. ALARA and Radiological Design Plan
4. Radiological Design Scope
5. Radiological Condition
6. Facility/Operational Layout
7. Installation and Setup Considerations in a Active Radiological Area
8. Maintenance and Operations
9. Shielding and Dose Rate Determination
10. Contamination Control
11. Access Control
12. Liquid Systems (Tanks, Pumps and Sumps and Slurry Systems)
13. Piping
14. Instrumentation (radiation and non-radiation)
15. Ventilation
16. Filters and Demineralizers
17. Supplied Personnel Breathing Air System
18. Implementation or Modification Design Considerations
19. Waste Minimization

Note: Additional requirements and guidance on some topics above are contained in other ESM chapters. In the case of conflict, requirements elsewhere take precedence over this guidance; conflicting guidance shall be resolved by the Radiation Protection POC and the POC of the respective discipline. Decision and outcome shall be documented and approved by both POCs.

3.4 Assistance for Radiological Engineering Design of Operations and Facilities

A. Contact the HSR-12 Radiological Engineering Team Leader if you have any questions, concerns, clarification or need assistance for any radiological design effort. If unavailable, others on the Radiological Engineering Team are available. The phone number for the HSR-12 Group Office is (505) 667-5296.

4.0 APPENDICES

Appendix A, Radiation Protection Design Considerations and Features *(Guidance)*

ENDNOTES:

1 DOE O 420.1, Section 4.1.

2 LANL LIR 220-03-01, "Engineering Standards" is the implementation requirement document for this manual. Refer to Sections 2.0 and 3.0 for statements of the purpose, scope and applicability of the ESM.

3 DOE G 420.1-1.

4 IR402-700-01, Occupational Radiation Protection Requirements.

5 LIR402-700-01.

6 LIR402-700-01.1221 & 10CFR835.1001(a)

7 LIR402-700-01.1221 & 10CFR835.1001(a)

8 LIR402-700-01.1221 & 10CFR835.1001(a)

9 LIR402-700-01.1221 & 10CFR835.1001(a)

10 LIR402-700-01.1221 & 10CFR835.1002(a)

11 LIR402-700-01.1221 & 10CFR835.1002(b)

12 LIR402-700-01.1221 & 10CFR835.1002(b)

13 LIR402-700-01.1221 & 10CFR835.1002(c)

14 LIR402-700-01.1221 & 10CFR835.1002(c)

15 LIR402-700-01.1221 & 10CFR835.1002(d)

16 LIR402-700-01.1221 & 10CFR835.1002

17 LIR404-300-01

18 LIR404-300-01

19 LIR402-700-01.724 & 10CFR835.2

20 LIR402-700-01 & 10CFR835.2

21 LIR402-700-01 & 10CFR835.2

22 LIR402-700-01.1221/Chapter 14 and 10CFR835.2

23 LIR402-700-01.1221 & 10CFR835.2

24 LIR402-700-01.1221